Interim Contractor Report #2

12/01/96 - 12/31/96

Physics of Boundaries and their Interactions in Space Plasmas

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I. Bow Shock & Foreshock:

We are continuing our large scale hybrid simulations of the bow shock. In particular we have examined the effect of IMF direction on the large scale structure of the shock/Foreshock system. By performing shock normal diagnostics, we were able to demonstrate that the foreshock is the result of ion reflection and leakage from only the quasi-parallel side of the bow shock with shock normal angles below about 42 degrees. We also spent a considerable time preparing diagnostics and figures in order to develop a coherent picture of our simulations results which were then presented at the Fall American Geophysical Union meeting.

II. Kelvin-Helmholtz Instability at the Magnetopause and the Magnetotail:

We used a combination of 2-D and 3-D hybrid simulations to examine the effect of the velocity shear on the stability of the magnetotail and the magnetopause. We demonstrated that the presence of secondary ions at the magnetopause (e.g., cold ring ions, heavy elements) can lead to the excitation of Kelvin Helmholtz (KH) instability at or near the subsolar point. This is in sharp contrast to previous studies where it was thought the KH could only be excited at the flanks. We also identified several ways that KH could be excited in the magnetotail. Our preliminary results suggest that the KH could lead to destabilization of the tearing mode in the magnetotail. The results were presented at the Fall American Geophysical Union meeting.

III. Large-Scale Hybrid Simulations of the Magnetotail:

Previously, we successfully used the 2-D hybrid code to simulate the large scale structure of the distant magnetotail. As a next step in our research, we have started tackling the more complex physical configuration of near-Earth reconnection and its consequences. The near-Earth problem has several added complications: (1) such simulations require a 2-D equilibrium model; (2) a reflecting particle boundary condition is needed at the earthward side; (3) open (self-adjusting) boundary conditions should be used at the lobes to allow the internal plasma to determine the reconnection time evolution. We have implemented these changes to our code and have for the first time performed several large scale simulations with these new boundary conditions, the results of which were presented at the Fall American Geophysical Union meeting.

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This report describes the work done by SciberNet, Inc. during the month of December. Much of the work performed during this month involved preparing the three talks that we gave at the Fall American Geophysical Union meeting. To this end, we further developed and refined our demonstration of the fact that the quasi-parallel part of the bow shock is the sole contributor to the ion beams in the foreshock. In a second area of research, we identified new mechanisms for the excitation of the Kelvin-Helmholtz instability at the magnetopause and the magnetotail. Given the 3-D nature of our simulations, we have also started development of data visualization tools in 3-D. Finally, we made several large scale 2-D hybrid simulations of the near magnetotail with new boundary conditions to allow for unbiased plasma and flow evolution during magnetic reconnection.

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